Paper sensor passes another milestone

A laser ultrasonic sensor designed and built by scientists from US Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) has successfully tested at a paper mill in Jackson, Alabama.

The sensor measures a paper's bending stiffness and shear strength as it goes through a production web.

This ensures the optimum amount of raw material is used to make the paper, which could reduce the consumption of pulp and chemicals, saving the US paper industry some $200m in energy and $330m in fibre costs yearly.

Specifically, the sensor measures the time it takes ultrasonic shock waves to propagate from a laser-induced excitation point on the moving paper to a detection point several millimeters away.

The velocity at which ultrasound waves travel through the paper to the detection point is related to two elastic properties, bending stiffness and out-of-plane shear rigidity.

The recent trial boasted the highest sample speed ever reported for a commercial application of laser ultrasonics.

"This is the first full-scale demonstration of the sensor on a commercial paper-making machine while it's in operation," says Paul Ridgway of Berkeley Lab's Environmental Energy Technologies division. He developed the sensor with the project's principal investigator and fellow scientist Rick Russo, in partnership with the Institute of Paper Science & Technology at Georgia Tech. The 2-week test was conducted by a Boise Cascade mill.

"Boise Cascade's engineers considered the trial to be quite successful, and are hopeful that a six-month trial will be conducted at the same mill," says Ridgway.

Eight years in the making, the sensor was funded by the DOE's Office of Industrial Technologies in a partnership to improve energy efficiency in several industries. Under this program, the American Forest and Paper Association created Agenda 2020, which outlines ways in which the forest products industry will streamline production processes.

Papermaking is a candidate for improvement. To gauge paper quality today, a 15 to 30-ton paper roll is manufactured, a few samples are obtained from the roll end and analysed for mechanical properties by observing how they bend.

If samples don't meet specifications, the entire roll is recycled. To avoid this costly mistake, manufacturers often over engineer paper, using more pulp than necessary to ensure the product isn't sub-standard. This consumes more raw material and energy than necessary, so the Berkeley Lab team developed a sensor that tracks paper flexibility in real time.

The next step in the project is to work with Boise Cascade to link the sensor with sophisticated feedback controls that maintain the paper's stiffness while it's being manufactured.

ABB Corporation, which participated in the recent trial, is also likely to participate. "Our technology will enable real-time feedback control," says Ridgway. "And the successful mill trial shows we are one step closer to realising it."

In 2003, Ridgway, Russo and engineers from the Institute of Paper Science & Technology conducted a pilot-scale test of the laser ultrasonic sensor at Mead Paper Co's research center in Chillicothe, Ohio.

This test first demonstrated that the sensor's sophisticated hardware can successfully perform under the harsher conditions of an industrial environment.

Laser senses stiffness and sheer